Introduction

The coast is emblematic of California, from sunny, sandy beaches with volleyball courts and lifeguard towers to redwood crested rocky crags. California's climate, ecology, and economy are intertwined with the coast and ocean and these connections offer a perfect learning opportunity for middle and high school students to delve into interesting and complex subjects.

California Coastal Voices is a project-based learning tool designed to address science, social science, and environmental literacy. The projects and activities note specific connections to the Next Generation Science Standards performance expectations and three dimensions, the History-Social Science Standards, and California's Environmental Principles and Concepts. Consisting of six "projects" or stand-alone units that introduce students to coastal conflicts, challenges, and scientific and policy issues, the emphasis is on problem solving and communication. The projects, which can be modified to meet student interests and needs, will be especially useful for teachers of environmental science or those who seek to integrate Earth science into biology, chemistry, or physics classes. Several of the projects work well in government and seminar classes.

California Coastal Voices incorporates strategies that have been teacher-tested and proven in classrooms throughout California and are endorsed by the *California Science Framework*, including:

- Problem-based learning, a form of project-based learning as articulated by the Buck Institute for Education
- The BSCS 5E instructional model (engage, explore, explain, elaborate, evaluate)
- Science notebooks
- Outdoor learning experiences

California Coastal Voices supports student learning of California's *Environmental Principles and Concepts* to nurture and celebrate environmental literacy. Students participating in the *California Coastal Voices* projects explore natural systems, consider how people influence natural systems, and are empowered to directly participate in decision-making about complex natural resource management issues. Students investigate local environments as their context for learning and think about how human society has altered and been influenced by natural functions. Keeping learning relevant to students' own lives supports educational equity by empowering students to be agents of change in their communities.

> "The learning cycle, or 5E sequence of instruction, is one of the science education community's most studied, tried-and-true approaches for helping students learn about science content and practices."
>
> "The CA NGSS emphasize the importance of making sense of phenomena and solving problems by using all three dimensions of learning [i.e. science and engineering practices, disciplinary core ideas, and crosscutting concepts]. Instructional approaches such as problem-based learning and project-based learning provide students with the time and support to successfully engage in three-dimensional learning."
>
> *2016 California Science Framework*

The *California Coastal Voices* projects fall into two types:

- **Teacher-Guided Projects** are designed to be accessible to most secondary school teachers. The three *Teacher-Guided Projects* have more scaffolding, are more tightly-constructed, and are less open-ended than the *Student-Driven Projects*. They include step-by-step instructions for classroom activities, and although these activities work best as part of the entire Project, most can be pulled out for stand-alone use. Key elements of project-based learning are woven into an enhanced 5E learning cycle with an instructional focus on the crosscutting concepts from NGSS and two key science and engineering practices: arguing from evidence and modeling.
- **Student-Driven Projects** have been designed to incorporate the elements of high quality project-based learning as articulated by the Buck Institute for Education. While accessible to any motivated teacher, the three *Student-Driven Projects* are most suitable for teachers with experience managing highly differentiated student-driven classrooms, high levels of student choice, and project-based learning routines.

Art by Alejandra Martinez, 10th grade

Please read *Organizing for Student Success* to orient yourself to the contents of the guide and tips for teaching. *Essential Elements of Project-Based Learning* provides background on this instructional strategy. Following the six projects is a Readings and Resources section that contains tools for group learning, rubrics for self-assessment, and readings on California coastal law and on remote sensing analysis that are required for some projects. Finally, please make use of the *Coastal Voices Website* at **www.coastal.ca.gov/coastalvoices** for slideshows, images, videos, and links needed for the projects as well as for additional teacher background reading.

Thank you for bringing the California coast into your classroom and helping to inspire your students to be engaged, active, educated stewards of our natural world. California, the nation, and the ocean are waiting for them.

Organizing for Student Success

What follows is an overview of the tools and strategies in *California Coastal Voices*. "Part A" is applicable to all six Projects, both *Teacher-Guided* and *Student-Driven*. It includes a description of tools, suggested classroom strategies, two methods of assessment, and a chart showing student and teacher roles over the course of a project. "Part B" provides additional guidance specifically for *Student-Driven Projects*.

Part A: Teacher-Guided and Student-Driven Projects

Tools

- The **Daily Phenomenon** is a warm up for use in the first minutes of class. This tool, which is built into the *Teacher-Guided Projects*, focuses on crosscutting concepts and constructing arguments from evidence. *Student-Driven Projects* also benefit from implementing this routine. The Daily Phenomenon is the "engage" step of the 5E cycle for a single class session and is often an image (downloadable from the *Coastal Voices Website* at **www.coastal.ca.gov/coastalvoices**) for students to analyze independently in their notebooks.
- **Thematic Slideshows** featuring the California coast are available as downloads from the *Coastal Voices Website* and are used in some of the *Teacher-Guided* activities as well as for the Daily Phenomena.
- **Making Sense of Images** and the **Guiding Questions for Image Analysis** support student acquisition of the crosscutting concepts, geographic familiarity with the coast, and ability to construct arguments from evidence. Both are available in the Readings and Resources section of *California Coastal Voices*.
- **Go Deep** sidebars are opportunities to delve further into significant topics via additional labs, diagrams, readings, or complementary curriculum from partners such as NOAA, Lawrence Hall of Science, and NASA.

Key Instructional Strategies

Prep for "Just in Time" Personalized Instruction before the project begins. Teachers should spend time with the technical issues addressed in the project, background readings, and NGSS performance expectations to ensure that content knowledge can be deployed as needed.

Group Management Contracts are a critical component of managing project-based learning. Should time allow, guide students through the process of creating group agreements. There are many examples online, ranging from simple to complex. You will find a sample *Group Management Contract* in the Readings and Resources section.

Group Roles help ensure accountability and smooth work flow within student teams. Additionally, they encourage teenagers to try on various professional roles. The following suggested roles are referenced within *Student-Driven Projects* and may be assigned for *Teacher-Guided Projects* as well:

1. Principal Investigator: The project leader partners with the teacher to advance the project. Specific responsibilities include attending mini-lessons (research strategies, time management, prioritization) given by the teacher, teaching those same concepts/skills to their team, and relaying logistical information to the team.
2. Scientist: In partnership with the teacher, the scientist leads the team in science thinking, attends mini-lessons and labs led by the teacher, and focuses on explaining the natural world using evidence, conceptual models, and reasoning.
3. Engineer: Students in this role define problems and potential engineering solutions. They make choices about solutions based on the best available science, relevant government policies, and availability of resources. They attend engineering briefings as assigned by the teacher and lead designing, building, and testing any material objects the team decides to construct.
4. Policy Analyst: This role requires keeping one foot in environmental science and the other in government policy and benefits from an ability to think and reason following legal frameworks. This person attends policy briefings offered by the teacher and conveys concepts to the team.

Get Outside: Leaving the classroom to interact with the community is even better than bringing professionals into the classroom. The enhanced learning experience is worth the effort of coordinating with other teachers, scheduling transportation, and filling out paperwork. Most of the projects in *California Coastal Voices* can be done without leaving the classroom (or easily altered to that end); however, all are improved by engaging learners with the world beyond the school. Facilitating a field experience may mean partnering with afterschool organizations, local non-profits, and parents.

Student Assessment Routines

Self-Assessment with Rubrics

Assessment is designed to support students as they learn to manage their own learning, thinking processes, and formative interactions with adults. A key goal is helping students visualize and cultivate desirable Habits of Mind as articulated by Costa and Kallick, especially creative questioning, persisting to completion, and listening with empathy and understanding.

How do you make a Habit of Mind visible, learnable, and measurable for students? One answer is to clearly frame a goal referencing a specific Habit of Mind, develop observable indicators with your students, and consistently focus upon those indicators during formative and summative evaluations. Rubrics are a way to frame and assess these goals. Four rubrics to be used with every project are included in the

16 Habits of Mind goals:

- Persisting
- Managing impulsivity
- Listening with understanding and empathy
- Thinking flexibly
- Thinking about thinking (metacognition)
- Striving for accuracy
- Questioning and posing problems
- Applying past knowledge to new situations
- Thinking and communicating with clarity and precision
- Gathering data through all senses
- Creating, imagining, innovating
- Responding with wonderment and awe
- Taking responsible risks
- Finding humor
- Thinking interdependently
- Remaining open to continuous learning

Arthur L. Costa and Bena Kallick, 2000

Readings and Resources section of *California Coastal Voices.* Designed by the Buck Institute for Education, these rubrics cover critical thinking, creativity and innovation, collaboration, and presentation skills. Two additional rubrics are also available for the evaluation of scientific writing in formal papers, student journals, and exit tickets.

Assessment with Science Notebooks

Notebooks can help document changes in student thinking and can be a place to build out conceptual models or otherwise make thinking visual. The *California Science Framework* and the *California English Language Arts/English Language Development Framework* support science notebooks as a tool to differentiate learning and support student thinking and reflective self-evaluation. Throughout the Projects, students are encouraged to use their notebook for Daily Phenomenon analysis, developing and revising models, and individual reflection on daily Guiding Questions, as well as to keep track of their group project work.

Standards Connections

Teacher-Guided Projects articulate state education standards within the activity instructions and in a detailed table following each unit.

In *Student-Driven Projects*, learning goals connecting to standards are co-authored with students and included in personal learning plans.

Pismo Beach Pier. Photo: Janet Veta

Visualizing the Classroom

What are the students and the teacher each doing during the different stages of the 5E cycle in *California Coastal Voices* Projects? The following chart (modified from Bybee, San Diego County Office of Education, and J. Spiegel) offers an overview of both the routine of a single class session as well as the arc of an entire project.

	Enhanced 5E Stage	Student Role	Teacher Role
Invitation to Engage	Initiates the learning task, accesses prior knowledge, and organizes student thinking toward outcomes of current activities.	• Shows interest • Engages in problem and expresses own ideas • Asks questions such as, Why did this happen? What do I already know about this? What can I find out about this? How can this problem be solved?	• Raises questions or problems with a dynamic engaging event • Elicits responses that uncover students' prior knowledge • Helps students make personal and place-based connections to project • Posts challenging question and performance task (real world problem to be solved)
Explore Questions	Common base of experiences within which concepts, processes, and skills are developed.	• Creates conceptual models, questions new ideas • Discusses problems with others. Records observations and ideas in project notebook (Continues every week)	• Helps students develop a detailed question • Provides common experience • Observes and listens to students • Acts as a coach for students • Gathers final evidence of student understanding
Explain & Reflect	Students demonstrate their understanding. Teacher provides resources and information to support student learning. Formal definitions and science details are provided.	• Explains possible solutions or answers to other students • Listens critically to and questions other explanations • Refers to science and engineering practices • Uses evidence and vocabulary	• Encourages students to explain concepts and definitions in their own words • Asks for justification (evidence) and clarification from students • Formally provides definitions, explanations, and new vocabulary through mini lecture, text, or Daily Phenomenon • Builds on student ideas and explanations
Elaborate & Extend in to Application	Students' understanding is challenged and extended, Habits of Mind are further developed. Knowledge is applied to real world issues in the community.	• Applies new understanding and skills to community action • Proposes solutions, makes decisions, designs further experiments, or completes a challenge • Creates models and arguments from evidence	• Supports students as they use vocabulary, definitions, and explanations previously developed from experience • Encourages students to apply the concepts and skills in new situations • Provides alternative explanations
Evaluate with Public Product	Teacher and students assess understanding and skills. Assessment is formal and informal, summative and formative.	• Gives another student feedback • Self-assesses progress and knowledge • Checks work with a rubric	• Asks reflection questions: Why do you think…? What evidence do you have? Where could you go from here? • Gathers final evidence of student understanding

Part B: More Guidance for Student-Driven Projects

Effective management of learning experiences and careful implementation of classroom routines are the foundation of the *Student-Driven Projects*. Links to additional resources for teaching using the project-based learning model can be found on the *Coastal Voices Website* at **www.coastal.ca.gov/coastalvoices**, but three recommended actions for teachers are briefly explored here:

- Initiate a **culture of inquiry** emphasizing creative questioning, continuous improvement, and student leadership.
- Design and execute **project entry events** and other invigorating, shared learning experiences.
- Deploy **process management tools**: process guides, learning rubrics, contracts, checklists, project roles, and discussion protocols to scaffold learning.

Create a Culture of Inquiry

Project-based learning classrooms are like road trips in that the quality of the experience depends on who steers, controls the speed of movement, and chooses the destination, with the goal that burdens are shared, questions are raised and answers are sought jointly, and accomplishments and failures are regarded as equal opportunities to learn. Consider reserving a regular period for class activities that support desirable Habits of Mind such as student independence, an inclination to question, attention to quality, personal growth mindset, and team spirit. Visit the *Coastal Voices Website* for suggestions.

Launching Projects with a Powerful Entry Event

Effective projects are launched by great entry events, encouraging sustained activity driven by personal interest and the desire to understand. They must be exciting for students, convey the teacher's enthusiastic commitment to the subject, and raise questions that need to be answered. It is these questions that guide the project forward to success. In *Student-Driven Projects* you are encouraged to start with a high quality speaker with direct experience of the challenging question. If this is not possible, good alternatives include videos or online meetings such as those facilitated by the PORTS program of California State Parks.

Process Management Tools included in the Student-Driven Projects

I. Teacher Guides include preparation tasks specific to the Project and may provide background reading for teachers along with weekly questions. To encourage strategic questioning by students, an option is to have one student from each group investigate a question in the *Teacher Guide* and report out to the group. Another strategy is to support the students in finding their own way to these questions. Individual or small group guidance should be provided as needed to ensure that significant facts, concepts, and principles are understood.

II. Teacher Checklist for Student-Driven Projects is found in the Readings and Resources section and guides the teacher in their responsibilities from a Project's start to finish.

III. Student Readings in the *Student-Driven Projects* orient students to the tasks inherent to each phase of the Project and provide a tool for accomplishing the task. The readings align to the following sequence (a version of the 5E instructional cycle):

1. **Invitation to Engage:** This first reading states the challenging problem introduced during the engaging entry event, helps students understand why the Project is important, and helps them determine with whom they will share the work. The *Student Checklist* points the way forward and should be handed out soon after the *Invitation to Engage*.
2. **Explore Questions:** *Asking the Right Questions*, found in the Readings and Resources section, provides structure and a question formation tool for students as they ask need-to-know questions related to the challenging problem. Teachers use the *Teacher Guide* to support student efforts to ask significant questions, direct students towards Next Generation Science Standards disciplinary core ideas and performance expectations, and help students find trustworthy sources.
3. **Explore and Explain Arguments** with the *Claims, Evidence, and Reasoning Guide*, found in the Readings and Resources section. This tool makes student thinking visible as it provides a template for developing evidence-based arguments. Teachers provide guidance and instruction to groups and support students' self-assessment efforts during this time. Students use the claims, evidence, and reasoning tool to construct arguments from evidence.
4. **Extend (Elaborate) into Application:** These readings, which are specific to each Project, give guidance on performing the concept-reinforcing, out-of-classroom activity (leading a field experience, joining a volunteer restoration project, or informational interviewing) that is designed into the *Student-Driven Projects*. Teachers support students with direct instruction and assist in making connections with organizations and individuals as needed. If necessary, Projects can be altered to remove the out-of-class component.
5. **Evaluating, Communicating, and Reflecting:** Part inspiration, part instruction, *Tips for Effective Communication in Public Settings* and *Students Taking Action* (both found in the Readings and Resources section), guide students as they publicly present the group's learning product. This may be handed out as early as week three when students begin practicing their presentations. Teachers help students self-evaluate, provide peer feedback, and facilitate reflection.

IV. Personalized Learning Plans, co-authored between the teacher and each student, are key to a *Student-Driven Project*. Your objective is to:

- Include the student's interests.
- Link to significant performance expectations (NGSS/CC), essential content knowledge, and local environmental issues.
- Create a foundation for reflective self-assessment, personalized teacher feedback, and parent reporting.

One strategy for launching the development of Personalized Learning Plans is to start with a whole group discussion about goal setting by considering the Challenging Question, required learning products, and the rubrics. Do this after the engaging

event—if possible the same day. Frame the conversation around desirable Habits of Mind such as persisting to completion or communicating with clarity and precision.

The SMART (Specific, Measurable, Achievable, Relevant, Timely) goals format is a tool that can be used for creating personalized learning goals. There are many variations on this goal-setting prompt. A suggested *Student's Guide to Personalized Learning Plans* can be found in the Readings and Resources section.

Kelp wrack in Monterey. Photo: Amy Williams

Essential Elements of Project-Based Learning

The following is based on work performed by John Larmer, John Mergendoller, and Suzie Boss of the Buck Institute for Education (authors of *Setting the Standard for Project Based Learning*), and describes the essential elements of project-based learning and how they are reflected in *California Coastal Voices.*

Student Learning Goals

Project-based learning is one of the instructional strategies highlighted in the *California Science Framework* as "congruent with the principles" of three-dimensional learning—the notion that learning should weave together skills and practices, crosscutting concepts, and content knowledge acquisition. Each *California Coastal Voices* Project supports this type of learning. Equal emphasis is placed on acquiring specific knowledge and on thinking and working like a scientist or engineer. Knowledge is most effectively retained through habitual application; skills are honed through practice towards measurable mastery.

> "When teachers integrate all three dimensions of the CA NGSS, their classrooms look different...Both the *NRC Framework* and the CA NGSS highlight a vision for student learning centered on the development of practices and knowledge that will transfer beyond the classroom and beyond formal K–12 schooling. In particular, the aim is to prepare all students graduating from high school to be critical consumers of information and capable problem-solvers and to engage in public discussion using evidence-based argumentation across a broad range of topics."
>
> *2016 California Science Framework*

Essential Project Design Elements in California Coastal Voices

Entry Event and Challenging Question: Each Project begins with an entry event that inspires, excites, and engages the students (often a guest speaker but sometimes a video or video conference), and a Challenging Question that students respond to, modify, or discard in favor of co-authoring a related question. The question prompts the use of science and engineering practices to learn significant content and requires thinking across traditional content boundaries guided by the crosscutting concepts.

Sustained Inquiry: The Projects are designed to last three to six weeks and may in some circumstances lend themselves to longer time periods. Supporting sustained inquiry is a primary task for teachers as students are asked to go beyond internet searching to interviewing professionals, finding primary source documents, and performing field work. Each student team must explore the needs and perspectives of a variety of stakeholders and constituents. Content learning is supported by placing knowledge into action in the *Student-Driven Projects* by restoring natural environments, proposing solutions to government agencies, conducting field activities with community members, or helping peers explore coastal career opportunities.

Authenticity: Using real world issues as context for learning increases student interest and motivation (NRC and Larmer, 2016) and so are emphasized in all the *California Coastal Voices* projects. Service to the community is part of the *Student-Driven Projects*.

Student Voice and Choice: Meeting the challenges facing the world today and in the future requires leaders and problem-solvers who will take initiative. Schools can help create these citizens by letting kids explore what matters to them and teaching them how to tackle real-world problems. In *California Coastal Voices*, various levels of student voice and choice are designed into each Project. In the *Teacher-Guided Projects*, student voice and choice ensures student activation. In the *Student-Driven Projects*, students are given more latitude, up to full co-authoring of goals, methods, and presentation options if circumstances allow.

In all of the Projects, teachers have the flexibility to alter the amount of student choice. In the final analysis, teachers will consider student readiness, school culture, students' comfort with student-led projects, and other constraints before deciding on the degree of voice and choice. One key exception relates to organizing project teams; for effective groups, classroom teachers should control this process.

Reflection: If experience is the teacher, structured reflection is the pathway to performance. Science notebooks, self-assessments, and peer reviews are built into each Project. These reflection tools offer students structure as they make their way through the messy business of questioning, exploring, explaining, and extending into action. Teachers should share their own reflective thinking during conferences, casual conversations, and progress checks to demonstrate this important Habit of Mind for students.

Critique and Revision: Frequent feedback from teachers (formative assessment) is a key influencer of quality learning environments. Research by John Hattie of the Melbourne Educational Research Institute supports self-assessment, peer review, professional mentoring from working adults, and teacher evaluation routines. As Dr. Hattie states in *Visible Learning for Teachers: Maximizing Impact on Learning*, "The student's role is not to simply do tasks decided by teachers, but to actively manage and understand their learning gains. This includes evaluating their own progress, being more responsible for their own learning, and being involved with peers in learning together."

In *California Coastal Voices*, significant content knowledge is monitored over the entire course of a Project and is assessed via individual drafting, revising, and editing of written products. This gives teachers many opportunities to adjust instruction. Rubrics are used to evaluate critical thinking, communication, collaboration, creativity and willingness to innovate.

Public Product: This is the culminating activity of many of the Projects in *California Coastal Voices*. Making the learning product public creates a positive pressure towards accuracy and clarity of expression. Knowing that the work can make a difference in the community is also part of the motivation equation.